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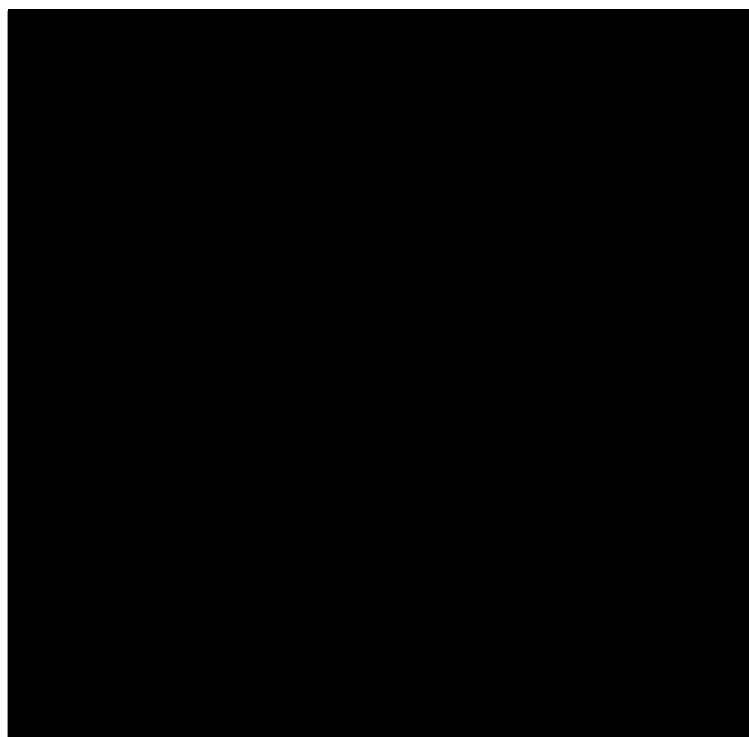
MATCHING TIME OF DAY AND PREFERENCE FOR ADOLESCENT  
ACHIEVEMENT

by

Leisha Moree Parker

A Dissertation  
Submitted to the Graduate School  
of The University of Southern Mississippi  
in Partial Fulfillment of the Requirements  
for the Degree of Doctor of Philosophy

Approved:



August 2009

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2009

The University of Southern Mississippi

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ABSTRACT

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by Leisha Moree Parker

August 2009

Research shows that adolescents enter a circadian-phase delay as they approach and enter high school. On or about age 14, teens become less of a morning learner due to biological factors. Researchers have determined consequences to the adolescent's circadian shift as related to learning; therefore, morning time may have a negative influence on the cognitive functioning of teens resulting in lower test scores. This study was an attempt to determine if time of day, gender, and learning preference using the Morningness/Eveningness Scale for Children (MESC) as proposed by Carskadon, Vieira, and Acebo (1993) would result in a statistical difference in test scores. Chronbach's Alpha reflected a .75 internal consistency of reliability of this instrument.

The sample was 162 students from a local high school's technology classes between the ages of 14 and 19. An analysis of differences between morning and afternoon classes regardless of gender showed a statistically significant difference. A surprise finding from four groups—morning learners in morning classes, morning learners in afternoon classes, afternoon learners in morning classes, and afternoon learners in afternoon classes—noted that the three groups with an afternoon component in their learning outscored the one group with no afternoon influence in their learning—morning students with a morning learning preference.

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## CHAPTER I

### INTRODUCTION

Educational failures addressed in *A Nation At Risk* (USDE, 1983) have alarming predictions of learning failures for public school students in the United States. According to this report, students in the United States were falling behind students in other parts of the world. Students in the United States were no longer competing with peers sitting across the aisle from them or the students standing next to them in the lunch line, but rather students compete with unseen pupils sitting in classrooms in Japan, India, and Western Europe.

*A Nation At Risk* (USDE, 1983) critiqued educational shortcomings in relation to societal demands. In summary, this report stated that public schools in the United States are not preparing life-long learners who can successfully compete in an ever-changing, global society. When society changes, it is inevitable that educational institutions must change also. The *Risk* report forecasted failure for United States' students because public schools were failing to equip students with the knowledge and skills necessary to compete in an outsourced, highly technical era.

The *No Child Left Behind Act* (NCLB) of 2001 was passed nineteen years after *A Nation At Risk*. This most recent attempt to address United States competitiveness was approved by Congress and outlined directives on public school accountability through standardized tests (USDE, 2001). A crucial point of NCLB federal legislation, according to Howard Gardner (2008) is efforts to increase Math and Science scores by addressing curriculum and instruction instead of addressing diversified instruction. According to Gardner (2008), United States schools will realize significant increases in academic

achievement when politicians and educational reform enthusiasts recognize the impact of school and community partnerships instead of school and standardized tests partnerships.

### Problem Statement

An additional criticism of United States' educational reform is that standardized testing in general, which is the heart of NCLB accountability, is flawed and biased because standardized tests typically do not account for individual learner differences (Callan, 1995). While public classrooms in the United States are increasingly becoming populated with more diverse learners, schools are not only filled with culturally different groups, but within even homogeneous groups, differences among individual members are apparent also. Dunn (1990) attributes these differences to 60% biology and learning style strengths. Dunn (1990) states that students achieve higher tests scores and higher standardized test scores when students are taught through approaches that match their learning preference or learning strength.

Student success in a standardized test reform movement dictates changes in instructional methods. Therefore, in order to prepare tomorrow's students and guarantee a competitive employee for the world of work, public school teachers must teach and test according to the way students best learn (Callan, 1995; Koch, 2007). According to *A Nation at Risk* (USDE, 1983), excellence can only be reached at the level of the individual learner where performance is based on the limit of individual ability.

The educational reform theme of the past decade has been that learning is a component of individuality (Dunn, 1998; Gardner, 2006). Dunn, learning-style researcher, stated that most people have one certain time of day in which they feel they are able to best perform (Dunn, 1998). This preferred learning time is just one component

of her 21 learning-style model that provides rationalization that individualized learning raises test scores.

Emerging evidence dashes the idea that all people learn best in the morning. Popular opinion has previously held a time-of-day conviction that people are more refreshed in the morning e.g. the aphorism the early bird gets the worm; however, empirical evidence does not support that early morning learning is best for teenagers (Dunn & Dunn, 1993; Wolfson & Carskadon, 1998). Many observations exist that refute the idea that morning is the most productive time of day for teens include: sleepiness in their early morning classes, difficulty waking, and lack of attention in morning classes (Goldstein, Hahn, Hasher, Wiprzycka, & Zelazo, 2006). Now, what was once considered adolescent laziness may now be recognized as a function of biology, not indolence (Wolfson & Carskadon, 1998; Carskadon, 1999).

SAT, ACT, and state subject-area tests are administered in the morning, and according to Callan (1998) citing Dunn and Dunn (1993), 70 percent of students are not morning types. The use of these standardized test results to determine pass, fail, or adequate yearly progress without regard to the learner's preferred time to test may yield skewed results (Callan, 1995). For this reason, time of day may be a confounding factor in assessment (Virostko, 1983; Dunn, 1995) and accountability.

Administrators seeking to meet students' individual needs should consider the importance attached to test results and should make efforts to not only accommodate delivery methods but also match time of day tested with students' preferred time to learn (Wrobel, 1999; Callan, 1995). Morning testing may be biased against students who learn best late in the day (Wrobel, 1999). Because of the high stakes nature of mandated tests,

educators must pay particular attention to students who may be academically disadvantaged because of time of day of test delivery (Callan, 1995). The potential effect of matching optimal learning time and testing may be one of the most important equity issues neglected in tests such as the ACT and subject-area tests (Callan, 1995).

Researchers show that most children prefer morning time, adolescents and most young adults prefer afternoon, and the older adult prefers morning (Hasher, Goldstein, & May, 2005). While these general conclusions can characterize most people, there is not a one-size-fits all for any group or population (Smith, 1987; Banks & Atkinson, 2004; Carskadon, 1999). According to Wolfson and Carskadon (1998), a problem for adolescent achievement may be that most high schools start earlier than elementary school, which contradicts optimal learning for teens' chronology. Studies reveal that old learning paradigms and schedules expect students to achieve early in the day when physiologically the pubescent learner is most likely not ready. Learning problems in teens and academic failure may be exacerbated because of their inherent disposition in preferring afternoon learning.

High schools cannot continue to operate under the belief that wisdom resonates in the morning (Carskadon, 1999). Callan (1998) stated that a majority are at a serious learning disadvantage because school hours are in direct conflict with their peak efficacy period. While school schedules cannot possibly accommodate every student, schools must, of course, schedule morning classes for those that learn best in the afternoon and schedule afternoon classes for those who are morning learners. Banks and Atkinson (2004) suggested that schools provide a rotation schedule so all students could benefit from taking at least one academic course during their ideal learning time. Ramirez,

Talamantes, Gardia, Morales, Valdez, and Menna-Barreto (2006) found another problem in that schools are likely to schedule harder subjects for early morning, because previously ascribing to common sense there was a belief that students process and learn better in the morning because they are rested.

During the teen years, the body's circadian rhythm or internal biological clock is temporarily reset, telling the teen to fall asleep later and wake up later (Wolfson & Carskadon, 1998). This change in the circadian rhythm, or “learning gateway” (Carskadon, 1999) seems to be due to the fact that the brain melatonin is produced later at night for teens than it is for small children and older adults. This hormonal change makes it difficult for teens to be productive, alert, and industrious in the morning (Adolescent Sleep Needs and School Performance, 1998).

Biological change is inevitable in the adolescent's progression into young adulthood. The adolescent developmental period of puberty, hormonal changes, and circadian cycles being pushed to later in the day is but one of the hurdles presented in high school (Wolfson & Carskadon, 1998). Therefore, if circadian rhythm impacts intellectual and physical performance, school performance and cognitive aptitude are not unique but are synonymous and tantamount to each other.

Success under modern educational reform is measured through standardized test scores (Koch, 2007), but standardized testing may be ignoring physiological and cognitive factors in adolescent learning. According to Gardner (2008), federal mandates will find success in the public classroom when educators individualize instruction as opposed to streamlining instruction.

Koch (2007) further references Dunn's model by stating that teachers must adapt to accountability measures by revising their teaching methods. According to Dunn and Dunn (1993), all children learn differently because each is unique in their biology. Kamii and Devries (1993) stated that a child's individual learning schemes are further internally developed in children by their own personal interaction with environmental stimulus.

### Significance of the Study

Because current educational reform directs educators to measure student learning through standardized test, there are real world consequences for students whose natural preferred time of day for learning is not synced with time of testing. According to Callan (1998) and Hasher et al. (2005) all age groups are cognitively vulnerable to time-of-day effects. Dunn (1998) stated that adolescents' cognitive skills are influenced by predispositions to learning. At a student's off peak time, attention, retrieval, and remembering are more difficult because analysis and evaluation are best when there is harmony between preferred time of day for learning and testing time (Virostko, 1983). Dunn and Dunn (1993) contends that only 15 to 20 percent of all students can learn at any time of the day, and this sensitivity to time inhibits or promotes learning. According to her research, 80 to 85 percent of all students are not that versatile and have only one best learning peak time.

Academia could increase test scores and possibly eliminate time-of-day bias by deferring to a student's preferred time of testing when testing (Wrobel, 1999). As early as 1978 Dunn stated that teachers need "diagnose" (p. 2) each of their students in order to meet federal and state mandates. Fifteen years later, Dunn and Dunn (1993) stated that teachers cannot teach students effectively if they have no insight into how to help them

achieve, reiterating that meeting federal and state mandates begins with student-centered instruction.

While adolescence is a time of increased academic pressures, high school starting times are challenging for high school students (Carskadon, 1999). The traditional high school day schedule may actually be counterproductive for most teenagers in that it is best suited to the circadian rhythm of the morning-alert students. School schedules that begin early in the day may be prejudiced against those, who more often than not are high school students, whose body temperature and therefore alertness peak later in the day (Biggers, 1980).

Whenever students are forced to learn under circumstances that do not suit them, their learning is inhibited (Dunn & Dunn, 1993). Rita and Kenneth Dunn's learning model is categorized by strands of stimuli with psychological elements, including time-of-day learning preference. This study will focus on comparing students' learning preference, the time of day tests are administered--afternoon or morning, and gender.

### Purpose

The purpose of this study is to determine if afternoon learning is different than morning learning for high school students in a selected course. Through assignment by the master schedule software, some students will be taught during times which will and will not be matched with their preferred time of learning preference. This study will examine whether those taught during their preferred time will achieve higher than students who are mismatched with their preferred learning time. Like the Virostko (1983) study, this study will not examine scores by any student who does not have a preferred time to learn. By examining matching and mismatching time of test delivery and



preferred time-of-day learning style, this research will examine relationships among time-of-day preference, gender, and test scores.

Because this study examines a three-way interaction or variation between and within groups of variables and is not predicting performance, a three-way analysis of variance statistical method will be used to examine three independent variables (gender, time of day, preference) on one dependent variable (test scores).

### Research Questions

1. Is there a variation in test scores of students who are matched with time of preference and testing time when compared to students who are mismatched with time of preference and testing time?
2. And does gender cause a different interaction when time of day and preference are matched?

### Hypotheses

1. The mean scores for students who are tested during their preferred learning time will be significantly higher than those mean scores for students who are not tested during their preferred learning time.
2. The mean scores for afternoon matched male students will be significantly higher than those mean scores for morning matched male students.
3. There are significant differences between morning and afternoon learners regardless of time of day.
4. There are significant differences between morning and afternoon classes regardless of gender.

### Delimitations

The delimitations of this study are only the technology students at a local high school will participate, and this sample is taken from a single high school in a southern state. This sample includes only students enrolled in eight sections, in only two teacher's classes, of a single technology-related course during the Spring semester of the 2008-2009 academic year. Preferred learning time will be measured by the Morningness/Eveningness Scale for Children (Carskadon, M., Vieira, C., & Acebo, C., 1993). questionnaire. Morning classes occur before 11:04 and are before lunch, and afternoon classes occur after 12: and are after lunch. Levels may be a little larger for the afternoon learners. Students do not switch groups. This study will exclude test retakes and those students who are not present on the day of test administration but make up their test at a later date.

### Assumptions

The assumptions are that there will be differences in time preference some students will prefer morning learning and some students will prefer afternoon learning and there will be differences in test scores when time and preference is matched versus when time and preference is mismatched and that each student has reached their circadian shift and each student has one preferred learning time. The morning learners and afternoon learners will be approximately evenly distributed across gender. The time-of-day preference for learning will be accurately reported by each student.

These students are representative of the general population of high school students since this technology course is required for graduation.

## Definitions

*Afternoon learners* are those students who reach their body temperature peak at about 6 a.m., two hours later than morning learners (Cavallera & Giudici, 2008). Those who learn better later in the day (Callan, 1998).

*Chronology* refers to one's preferred time to learn (Banks & Atkinson, 2004).

*Circadian* refers to the 24-hour day-to-night cycle that governs our sleep-wake cycle, and rest-activity cycle relative to tasks (Wever, 1979). Circadian refers to a time of maximum alertness (Cavallera & Giudici, 2008).

*Learning Style* is the way a learner "begins to concentrate on, process, and retain new and difficult information. It is a combination of many biologically and experientially imposed characteristics that contribute to learning, each in its own way and all together as a unit" (Dunn & Dunn, 1993, p.2).

*Morning learners* are those learners who reach their body temperature peak at about 4 a.m., two hours later than afternoon learners (Cavallera & Giudici, 2008). Those who learn better in the morning (Callan, 1998).

*Time-of-day* is a construct "developed to estimate phase tendencies from self description" (Wolfson & Carskadon, 1998). An physical element of the Dunn Learning Styles Model where energy levels are highest (Dunn & Dunn, 1993)

*Synchrony* is matching time of delivery with time preferred (Banks & Atkinson, 2004).

## CHAPTER II

### REVIEW OF RESEARCH AND LITERATURE

#### Biological Implications of Adolescent Learning

Stating that 80% of learning style is biological (Dunn & Dunn, 1993), she wrote that a consensus in educational reform beliefs regarding delivering instruction according to a student's preferred style of learning is key in improving achievement (Dunn & Dunn, 1993). Dunn and Dunn (1993) list individual responses to sound, light, temperature, seating arrangements, perceptual strengths, intake, time of day, and mobility as biological where motivation, responsibility, and self direction as developmental. The theoretical basis of adolescent learning and time-of-day preference is rooted in the field of cognitive psychology and neurophysiology. Carl Jung (1933), responsible for analytical psychology, theorized that first learning must be psychological and second that environment influences learning. He reported through many writings that man does not evolve by developing solely within a shell of a genetic personality. This is in agreement with Piagetian theory whereby an individual's extrinsic and intrinsic factors can be barriers or enhancers to individualized learning. Both theorists set important precedents for understanding an individual's acquisition of knowledge later to be known as individual learning style.

Noting that thinking is psychological and structured, Jung (1933) stated that one's psyche is equated with life because one's psyche is comprised of all purposeful activities. If one's psyche is not independent of any conscious or unconscious act, then every appropriate or inappropriate stimuli ignored or acknowledged can affect that which binds to the conscious or subconscious. Learning therefore is many processes, unconscious and conscious ones, and evaluation of process depends upon individual interpretations which

are derived from an individual's state of mind. Individual "counter-positions" (Jung, 1954, p. 117) are not abnormal, but rather normal as personal differences are as numerous and diverse as personalities.

Jean Piaget also defined learning as an assimilation of biology and environmental influences. Piaget was one of the first to note that age was a prognostic factor in learning as children mentally developed in predictive stages. While noting that children are individuals, he recognized age patterns in early adolescent learning. His research was the first to begin documenting that learning came in biocompatible stages. Learning can occur only when a child is biologically ready to learn. According to Jung (1954), "isms" (p. 131) of the era are always serious. Dangerous are the subjective identifications of current trends when labeling one's collective consciousness. The measure of intelligence is subjective as children are exposed to different environmental influences.

While there have been attempts to determine how children learn best, the didactic world took note of different learning styles when Gardner (2006) published *Gardner's Theory of Multiple Intelligences*. Influenced by Jean Piaget's theory that people are individually unique learners with a biological predisposition governing learning, Gardner's work propagated an educational reform by introducing a new buzz word--individualized instruction. Teachers began to recognize that students learned best when delivery methods matched their students' individualized needs.

Gardner's research exists within a contradictory dichotomy. Society is a proponent of standardized testing, but standardized testing is not diversified and varied for the individuality of a learner. Therefore, the one-size-fits-all standardized tests cannot be a successful measure of public school children. He stated "while many tests have been built on Piagetian theory, for the most part; however, tests have been insensitive to

developmental considerations” (Gardner, 2006, p. 173) of children. Gardner’s supposition is that tests measure computational power but do not measure true intelligence, and like Piaget and Jung, asserts that a uniform view of learning is antiquated and obsolete (Gardner, 2006; Kamii & Devries, 1993).

Individual differences must be controlled for otherwise processes of the mind are not equally measurable and yield a perception of truth rather than the truth itself (Jung, 1954). This early evidence from Jung is reaffirmed in research by Howard Gardner (2006) when he stated that equally measuring outcomes cannot occur in equal contexts for different people.

Prior to Gardner’s differentiated learning theory, Rita Dunn and Kenneth Dunn (1993), modern-day instructional reformists, designed the Diagnosing Learning Style (DLS) assessment for students in grades 5 through 12. By acknowledging time of day as a physical element of an individual’s learning style, the DLS confirmed that learning often occurred according to an age-related peak time. Time, as a factor of the DLS, determined through survey a child’s highest point of energy, and the Dunns (1993) referred to this highest point of energy as peak time. Their research showed that a student’s high energy level time was the best time in which to study and do homework. Their research also confirmed that matching students’ instruction to time preference resulted in academic gain.

Dunn (1978) categorized elements of learning style to include environmental, emotional, sociological, physiological, and cognitive-processing preferences. The Dunn Learning Styles (DLS) Model is one of the most widely-used individualized learning blueprints. The DLS inventor, Rita Dunn, who is an educational advocate of individualized instruction, details a learner’s function within the following categories:

environmental influences include sound, light, temperature, and include sections of the classroom where interacting and sharing together enhances learning; emotional elements are intrinsic factors in which an instructor helps a student manage his own learning through motivation, persistence, responsibility, and structure of task; sociological elements in the DLS inventory is various patterns of working alone and with others; and the physical elements component of learning includes perceptual modalities (tactual, kinesthetic, auditory, and visual), mobility in the classroom, food intake, and time. Rita Dunn stated that children “function to learn” (1978, p. 5), and it is through their “constant” (1978, p. 4) functions not “dissonant” functions (1978, p. 5) that learning should be presented.

Learning is the constant way in which each individual concentrates, processes, and absorbs information. No one procedure, according to Dunn and Dunn, (1993) is better than another, just different. In early research the Dunns (1993) found that one’s interaction with environment actually determined whether learning was absorbed concretely or abstractly. The effect of the instructional environment in inhibiting or stimulating learning according to Dunn (1998) has been documented, but only in the past decade has matching learning styles and mismatching learning styles been studied in depth.

While the DLS inventory helps determine functions and components of a learner’s style, many elements can be diagnosed simply by asking the learner (Dunn, 1998). In 1995, Ammons, Booker, and Killmon found that learners as young as fifth grade were able to predict their preferred time of day for learning. According to Dunn (1998), one question such as “would you prefer to take an academically challenging class in the morning or afternoon” is sufficient in revealing a student’s preferred learning time.

While students may accurately be able to identify their learning style, Dunn (1990) cautions that even experienced teachers cannot without a valid and reliable instrument correctly identify all learning characteristics of their students, and sometimes may misinterpret behaviors or misunderstand their students' learning. Disputing that during the past decade cooperative learning was a commonly prescribed teaching method for all students, Dunn (1990) reiterates that not all students are cooperative learning types.

Virostko (1983) conducted a study of over 250 New York elementary students taking state subject area tests in Math and English. When analyzing scores, she wondered if those scoring poorly on the exams received instruction during their off peak time. She diagnosed the students' time preferences and accurately predicted that matched students would score higher than mismatched students. When instruction was matched with the students' preferred learning time, Virostko (1983) hypothesis was confirmed and results noted that students who received instruction matched with their time preference scored significantly higher on the achievement test than mismatched the students' preferred time.

Ammons et al. (1995) studied 36 fifth graders and found matching time-of-day preference and time of instruction resulted in academic gain in their Science class. She noted when she reversed the time of instruction with time-of-day preference, academic gain declined. She further concluded that there are implications for scheduling and taking tests even in small samples. Results of her study also noted that the teacher's preferred time of day to teach, played a role in student achievement.

In 2006, Goldstein et al. identified a mismatch of learning preference and time of day tests are administered as contributors of adolescent failure. Dramatic results were reported: IQ assessment rose as much as 6 points when time of day preference and testing time were matched. His study further reported that "over and above sleep" (p. 8)



synchrony, or matching, effects were more powerful in testing. His research was the first to find the relationship between synchrony and cognitive performance in adolescents.

While Dunn's early research in 1967 focused on improving achievement for disadvantaged learners, she quickly discovered that at-risk teens were not the only ones who benefited from learning through their constant, preferred learning style. In 1995 Dunn reported research showing that matching learning and preferred time of day for at-risk adolescents affected underachievers more than average performing students. However, when achieving students were matched, a significant gain of (.10) was subsequently noticed.

In other research, Dunn and Dunn (1993) suggested that time-of-day learning preference affected not only student achievement but attitudes, attention spans, tensions, behaviors, and/or attendance. Data also suggests that matching chronotype i.e. preference and time of testing is much more important than differences in sleep, interventions, tutoring, and remediation. Goldstein et al. (2006) stated that a teen's performance was a function of both individual morning or evening preference and the time at which assessment occurred. Testing students outside preferred time creates bias and skewed results. Therefore, standardized tests such as subject-area tests, ACT, GRE, and SAT may not reflect accurate measures of learning (Virostoko, 1983; Callan, 1995), at least for those students whose learning time does not match time tested.

Goldstein et al. (2006) was the first to examine chronology as a function of performance and made another equally significant determination when comparing and contrasting interventions and/or remedial work to the matching of chronotype and testing time--interventions, remedial work, and additional lessons do not create meaningful

increases in test scores when compared to the increases noted when matching testing time and preferred learning time.

According to Dunn and Dunn (1993), interventions, remediation, and tutoring require time, planning, resources and money. These measures do not go without success, but do require a large amount of two scarce capital resources found in schools--money and time. Her suggestion is a better and less expensive fix in increasing achievement: match testing time with preference. While Dunn's research lists the time-of-day element as one that may be typically hard to accommodate, she does state that with organization addressing students' different learning styles is possible: match a student's hardest core subject with their preferred time of day, administer standardized achievement tests at the students' best time of day, and allow students to tape record instruction when they are taking classes during their off peak, or non-optimal time (Dunn, 1995). Dunn (1978) also suggested an open-campus approach where a program or instructional package could be taken home for studying during a student's best learning time.

### *Circadian Effects*

Sleep researcher, Mary Carskadon (1999) recognized that within age groups differences among learners are natural, but within three age groups—the young, the adolescent, and the older adult--there are definite biological-related parameters in learning. As an adolescent experiences biological changes, specifically the onset of puberty, waking behaviors such as mood and school and task performance begin to change. According to Carskadon (1999), the adolescents' brain is influenced by bioregulatory systems that hamper the teen during the morning hours at school. Their natural biochemistry makes adequate adjustments to early high school schedule difficult. Hasher et al. (2005) noted, according to a study of 900 children ages 8 to 16, that this

natural occurring biological shift in adolescents typically begins at the onset of the teen years which is 13 years of age.

Circadian rhythm is an important learning theory that recognizes an internal timing mechanism, or clock, as a key component in performance. This intricate, autonomous, and self-directed cycle runs on a 24-hour, day-to-night and sleep-to-wake rotation (Wever, 1979). Cells possess internal 24-hour clocks, known as circadian. It is these clocks which regulate daily activities. In 1997 scientists at Northwestern University identified the gene that governs biological clocks. Maladjusted clocks can cause work problems, sleep problems, and impact cognitive and molecular bodily functions. The importance of this “clock” gene is that science has discovered the regulator of the temporal function (attention, memory, and learning) of all living cells (Science blog, 2004). Because individual circadian rhythms are unique and affect sleep-wake performance, biological influences might have educational repercussions that dictate learning ability and academic successes (Adolescent Sleep Needs and School Performance, 1998).

Adolescents experience changes in their bioregulatory system that manifests itself in their sleep-wake habits. These circadian changes shift within stages of pubescent and adolescent development (Goldstein, Hahn, Hasher, Wiprzycka, & Zelazo, 2006). Wever (1979) found these natural biological patterns were very resistant to change. Hasher et al. (2005) reported this shift begins at about 13 years of age, and reports other studies pinpointing 12 as the age such shifts occur. The conclusion seems to be that a morning-preference for learning is strong in childhood and that preference changes to afternoon as children enter adolescence. Hasher et al. (2005) found that adolescents performed better

in the afternoon if they considered themselves afternoon learners and performed better in the morning if they consider themselves morning learners.

The synchrony effect is rooted in biology. For adolescents there is a best performance time when learning and testing (Biggers, 1980). Given the fact that high school students could achieve higher scores if tested at their optimal times, schools using subject-area test scores as the final outcome-based determinant in passing and failing courses should reevaluate testing times before prescribing other interventions, such as tutoring and remediation. According to Dunn (1998), time of day is one of five elements affecting 70% of the achievement of students.

Kim, Dueker, Hasher, and Goldstein, (2002) studied time of day, gender, and ethnicity. Her sample of over 900 children ages 8 to 16 included Asians, African Americans, Caucasians, Hispanics, and Native Americans. She found younger children were more skewed toward being morning learners and older children shifted from a morning-learning preference at about age 13. In 2005, Hasher, Goldstein, and May found similar results in circadian shifts on or about 12 or 13 years of age.

Wolfson and Carskadon (1998) documented at the onset of entering high school, a shift to an afternoon preference in learning occurs, and as learners continue to age, learning preference seems to cycle back to morning again. In 1999, sleep researcher Mary Carskadon found that by the age of 14 the shift to afternoon becomes most evident. Her theory is that a delay in delays the shift, but by the time of age 14 most adolescents have fully experienced puberty. It is during this time that teens need more sleep, and they actually do not begin to require less sleep until the end of the teen years (Adolescent Sleep Needs and School Performance, 1998).

In 2008, Cavallera and Giudici suggested that time-of-day learning preference could be affected by the light-dark cycle at the time of birth. Reporting on two studies of over 1584 University students and 392 adolescents, morning types were more common among those students born in Autumn and Winter. They suggest that biological and environment influences of the light-dark cycle at birth may have circadian implications regarding the geographical light-dark cycle of where learners live.

According to Wolfson and Carskadon (1998), educators should not be asking what difference does such a biological shift create in learning, but rather to what extent and if the adolescent circadian shift affects learning when this shift becomes incompatible with school schedules, time of day tests are delivered, and delivery method (Carskadon, 1999). According to Kim et al. (2002), cognitive, social, and school performances are all influenced by the neurobiological mechanism of the circadian shift.

#### Time of Day and Performance

Are students better able to remember at certain times of the day? According to the report *School Mornings Too Early For Studying Teens* (2008), the biological rhythm clock of the typical high school student is off approximately 2.5 hours indicating that high school should not begin before 9 a.m. Sylwester (2007) reported that school schedules unfortunately force high schoolers into “jet lag” (p. 38) inhibiting brain energy. A later start time for high schoolers would allow the natural biology of the teen to be accommodated in relation to school demands. According to *Adolescent Sleep Needs and School Performance* (1998), adolescents experience this circadian delay. Their research reported that the majority of adolescents in their study reported they were most alert in the afternoon, thus reporting a preference for learning in the afternoon. This report further

indicated that if high schools could adjust their schedule by merely a 30 minute delay, academic gains would be realized.

Sousa (2003) states that sleep/wake cycles begin later for teens than for the younger student and the adult. Also, he states that early morning learning can, of course, occur for teens but is more difficult, because a teen's biology, hormonal concentrations, and circadian (daily) rhythms regulates ability to focus and learn. Sousa (2003) further noted the teen cycle is roughly an hour later than the preadolescent and adult, reasoning that the old cultural tradition of beginning high school early in the day should be revised.

Performance fluctuations have been noted in adolescent testing in these components when students' learning is mismatched with their chronotype (Callan, 1995; Dunn & Dunn, 1993). Students with afternoon preferences taking the SAT and GRE (offered in the morning) are at an extreme disadvantage and are likely to obtain a test score lower than they might have if allowed to test at their preferred time of day (Virostko, 1983; Dunn & Dunn, 1993).

Analyzing learning style and time preference of 245 Algebra students, Callan (1998) found that students preferring to learn in the morning scored significantly higher (.005) when tested in the morning, and students preferring afternoon learning scored higher (.055) when matched with their preferential learning time of day.

Goldstein et al. (2006) reported that subsets of an IQ test using 80 participants varied as much as six points when preferred time of day and testing time were matched. In a follow up with these 80 participants, he established that qualitative information from phone interviews when compared with the test scores showed the test results to be highly reliable ( $r=.93$ ,  $p<.001$ ). A follow-up phone interview also confirmed that with the onset of adolescence circadian shifting from morning to afternoon occurred. Sleep interaction

was quantified to determine if amount of sleep skewed reported results. Sleep duration had no effect on results. Sleep did not significantly interact with chronotype and time of day, and was determined to be a non-significant variable.

Biggers (1980) found that a student's academic success may be correlated to time of day. In a study of over 600 secondary students, he found that the majority, 56 percent, reported being more sluggish in the morning, and these students reflected a lower grade point average than those who reported being alert in the morning. While studying cognitive functions Biggers (1980), established that in the morning, males performed better on repetitive tasks, but the afternoon was the best time for males when performing perceptual tasks. He attributed the biology of the male, specifically the decline in testosterone throughout the day, as being a key factor in male perceptual tasks. He further concluded that males are more visually apt as the day increases due to male biology; therefore, a visually demanding task may be more difficult for males in the morning.

Supporting what Biggers (1980) found, Callan (1998) reported on athletes and morning time performance. When athletic teams were visually shown new maneuvers in the morning, they remembered these new maneuvers as if they had slept only three hours the night before. As a recommendation for best performance, demonstrations and new drills were subsequently taught to the athletes in the afternoon.

Englund (1979) studied adults in performance and in task as a function of time. He found with 11 females and 13 males, ages 18 to 48, that performance was related to circadian peak. Oral temperature, pulse, arousal, and anxiety were biological factors with 24-hour peaking rhythms. His findings indicated there was a circadian effect upon performance.

Gadwa and Griggs (1985) studied learning style preferences of 103 high school dropouts. This data was compared to the results of time-of-day preferences of 213 randomly selected high school students from five different high schools plus 214 alternative students receiving instruction in the evening. They reported results that not only confirmed that at-risk students are more likely to fail in the traditional school schedule but that the dropouts preferred evening as their optimal time for learning and had difficulty learning in the morning.

In 1987, Smith studied 10<sup>th</sup> and 11<sup>th</sup> grade New York students' math achievement when matched and mismatched with their time preference. She concluded when students' chronology requirement was met, they achieved significantly better ( $p < .10$ ) than other students.

In 1990, Cramp replicated Virostko's 1983 study with a smaller sample finding similar results. Approximately 180 fourth and fifth grade Missouri students were matched and mismatched with their learning time preference. Their reading instruction occurred in the morning; math instruction occurred in the afternoon. Teachers nor students were aware of which students were matched with their learning preference time and which students were not. According to the students' assessment of academic skills scores, students receiving instruction during their preferred reading time significantly outscored those mismatched in reading scores at the .05 level and math scores at the .05 level (Cramp, 1990).

Yoon, May, Goldstein, and Hasher (2008) found that when given varied cognitive tasks, adolescents improved their performance as the day progressed conforming to the synchrony effect as expected. At non-optimal times students are not as apt or ready or able to learn. Students not working at their preferred learning time have less control over



attention span, ability to evaluate and discriminate, which are necessary in learning. Yoon, et al. found other learning components negatively influenced by mismatching preference and time of day are attention span and memory.

Using a computer for stimuli presentation and response recording, Ramirez, Talamantes, Gardia, Morales, Valdez, & Menna-Barreto, (2006) found that circadian variations measured by body temperature are not only crucial to performance but affect memory and attention also. During a two-day study using continuous recordings of rectal temperature adults were given a visual fixation mark at the center of the screen, a stimulus appeared then a distracter appeared. Participants pressed keys to signify match and mismatch of visual indicators. Through testing of a drop in temperature and responses, Ramirez et al. was able to determine that working memory decreased as rectal temperature decreased and is similar to that found in other cognitive processes.

Hasher et al. (2005) cited a study of synchrony effect in resisting distraction in solving word-association problems. Younger evening-learner University students ages 18 to 24 were compared with older morning learners, ages 60 to 76. The groups were given a word recognition test in efforts to compare synchrony and cognitive function. When tested in the afternoon, the university students outscored the older adults 35 points. Astonishingly enough, when performance was tested in the morning, there was no age difference. The study found that younger adults improve cognitively as the day progressed, while older adults declined cognitively.

The conclusion being that age related differences in cognitive function should be controlled in research because age may be mistaken as a true covariate when in fact synchrony may be the confounding factor. According to Yoon et al. (2008), memory,

recognition, cues and recall conform to a synchrony effect in all ages because alertness and attention over distraction is impacted by circadian cycles in everyone.

In essence, circadian cycles impacts cognitive functioning and learning is a most demanding cognitive function for any age especially adolescents. Adolescents, while rapidly changing, have specific educational needs. Researchers seek to find relationships of measures and best practices to empower classroom learners. If tests are the means to an end result for teens, educational institutions must be ready to adapt the testing environment to meet the adolescent learners' needs—their biology demands as much.

## CHAPTER III

### METHODOLOGY

The purpose of this study was to analyze the matching and mismatching of learning preference, morning or afternoon, and time of day, morning and afternoon, tests were administered. Chapter III presents a description of the research design, participants, sample selection, instrument, procedures, and statistical analysis.

#### Research Design

The research questions addressed in this study are:

Question 1. Is there a variation in test scores of students who are matched with time of preference and testing time when compared to students who are mismatched with time of preference and testing time?

Question 2. Does gender cause a different interaction when time of day and preference are matched?

#### Participants

The participants were students enrolled in two sections of a Spring 2009 technology-related course consisting of four classes each at a local Blue Ribbon high school. This study used a convenience sample—and included students in a technology-related class taught by the researcher and students from another technology class taught by a different teacher in the same school. While not truly random, the high school's master scheduling software scheduled students to each teacher and each technology class based on the best fit for all classes the students took. This heterogeneous group of students ranged in age from 14 to 19 years. Both technology classes are required for graduation. Ninety-eight percent of the students were seeking a high school diploma and of these 48% were males and 52% were females; 13% were inclusion students. The

remaining 2% of students enrolled were not seeking a regular diploma but rather a Mississippi Occupational Diploma. Participation was voluntary.

### Sample Selection

The students in this study were from a local rural high school. Thirty-eight percent of the high school's students qualified for free lunch; an additional 10% of the students qualified for reduced lunch. Approximately 87% of the students were Caucasian; 12% were African American, and 1% were Asian. The convenience sample of 169 is adequate and assumed to be representative of the school's student population. The sample consisted of four morning classes, containing approximately 22 to 27 students in each class, and four afternoon classes containing approximately 22 to 27 in each class. For the purposes of this study Section A referred to one teacher's classes and Section B referred to another teacher's classes. For the purposes of this study, morning classes were those taught and tested before lunch; the time ranged from 7:45 a.m. to 11:04 a.m. Afternoon classes were those taught and tested after lunch; the time ranged from 12:11 p.m. to 3:01 p.m. Section A morning classes included class periods 2 and 3; Section A afternoon classes included class periods 4 and 5. Section B morning classes included class periods 1 and 2; Section B afternoon classes included class periods 5 and 6 (Appendix A).

### Instrumentation

Content-specific tests were administered through ExamView (2009) (see Appendix B for display examples), a test-generator software program, available with teacher resource materials accompanying the students' texts. ExamView (2009) was used to deliver tests over the local area network (LAN). The testing software program included three components: test builder, question bank editor, and test player. ExamView (2009) provided two testing options: LAN-based testing and Internet testing. For the purposes of

this study, only the LAN-based testing option was used. The test builder and question bank editor included options to create, edit, print, and save tests. The test player is a separate part of ExamView (2009) that enabled the students to take the technology LAN-based tests and receive, at the end of the quiz when the student chose the end-test option, feedback including right answers and the percentage-correct score. The ExamView (2009) software then loaded the class scores, item analysis, etc. to the server for teacher viewing.

While the tests used in this study included multiple choice and true/false items, the true/false items comprised no more than 15% of each test. Most of the questions came from the standardized test bank on compact disc provided along with students' texts; however, some teacher-made supplemental multiple choice and true/false items were included. The technology tests were based on the following various units of study: Excel, PowerPoint, Desktop Publishing, and Internet Research Skills.

Students logged in to ExamView (2009) at the beginning of the period by typing their last name and password. Prior to testing, all students' names were entered by the teacher into the ExamView (2009) roster. Students could only access each password-protected test once, at the beginning of the class, and only from the technology-class computer lab. This security feature made it impossible for the tests to be compromised via another lab or another computer in the school. Students listed on the roster, by section and class period, received the same test questions, but the order of the test questions were scrambled courtesy of the testing software. Teacher A and Teacher B used the scrambling feature for each test. ExamView (2009) delivered up to 26 different scrambled versions per testing session.

Each test consisted of approximately 20-35 multiple-choice, true/false, and/or matching. Only one question at a time appeared on the screen. Students selected the correct answer through use of a mouse. There was no time limit and students could revisit previous questions and change answers as necessary any time prior to choosing to end the test. Upon completion of the test, students exited their quiz and saw their results. The ExamView (2009) software marked and scored the students' test, and provided the correct answer along side missed questions. Students received immediate feedback from the ExamView (2009) results page. After reviewing their test, student exited the ExamView (2009) player which sent a data file to the teacher's computer. This data file listed students' percentile score by name, password, or name and password detailing test results for individual students as well as reporting class averages, item analysis by class, and standard deviations.

All tests were loaded to the LAN at the beginning of each class period and subsequently removed as students completed the tests. Because tests were not loaded or remained loaded on the server, students could not access the tests before or after scheduled testing times. The LAN was only accessible to students enrolled in the particular class of Teacher A or Teacher B and only through a designated classroom-based lab. The LAN where these tests resided was not accessible via other computers in the school. This LAN housed the tests in a read-only format; therefore, students were prevented from altering tests.

Students' learning preference was determined by self assessment from a questionnaire. During the first week of technology classes, students completed the Morningness-Eveningness Scale for Children (MES-C) (Carskadon et al., 1993) (Appendix C). This scale was designed for the adolescent population. Teacher A and

Teacher B gave a copy to each students (as shown in Appendix D), which took less than 10 minutes to complete. Copies were then returned to the teacher. The ten-item scale ranges from 10 (eveningness) to 42 (morningness). This instrument was designed to determine a student's preferred learning time through questions about sleep habits, alertness, and achievement. As noted in Appendix C, scores were derived by adding points for each answer, and those questions indicated with an asterisk indicated that points are reversed. Points awarded for 2, 7, and 9 were based on the scale of a=1, b=2, c=3, and d=4, while questions 1, 3, 4, 5, 6, 8, and 10 were awarded points based on the reversed scale of a=5, b=4, c=3, d=2, and e=1. In an effort to maintain the integrity of the instrument, students were unaware of the scoring procedure, and were subsequently given the questionnaire as shown in Appendix D.

Author's permission to use this form was given (Appendix E) as this instrument was reliable in ascertaining an adolescent's learning preference.

A computer program (see Appendix F) was written by the researcher, Teacher A, to count and score each student's questionnaire. The researcher, Teacher A, input answers from each questionnaire from all students, including those questionnaires from Teacher B's students. All questionnaires were input twice and scored once in an effort to check data entry accuracy.

The computer program consisted of two submodules--one contained four counters, for questions 2, 7, and 9; and one contained five counters for remaining questions. The program returned the MESC preference score which was hand recorded by Teacher A on each student's questionnaire, and later entered in SPSS for data analysis.

## Procedures

This study was approved by the Human Subject Review Board (Appendix G). Each student was given a Classroom Rules/Permission Form (Appendix H) to take home on the first day of technology class. The Classroom Rules/Permission Form explained that students' test scores would be used in research on differentiated learning. The parent, through the letter, was also notified there could be benefit to the student in learning more about their time-of-day learning style, that no names would be used or made public, and that this confidential data collection of test scores was an attempt to examine ways in which children learn which may be more academically beneficial to them. Parents signed giving consent, and students returned signed Classroom Rules/Permission Form. These signed forms were kept in the students' work-sample folders in the classroom. Only data from students whose parents signed and returned the form were included in this study. Of the 169 students enrolled in these eight select technology classes, four did not return permission forms.

No special time or place was created for the administration of the tests. No specific calendar day or week day was selected for the administration of the tests; tests were administered as part of the normal course of instruction. Students took the tests as they completed instructional units. All tests were given during the Spring 2009 semester. During the course of the investigation, students were given no more than seven standardized unit tests. Because of differences in the time allowances for block classes as compared to traditional classes, students in all eight sections were not taking the same amount of tests nor taking the same tests during the same week. While block classes meet twice as long as traditional period classes, students in Teacher A's block classes would not necessarily have taken all seven tests at the time of this study, simply because



they previously had tested on these prior. While no student took fewer than two tests, the average tests taken by each student was three. Students were provided ample time to complete the short tests, and no student required extra time outside the parameters of the class period. For Teacher A and Teacher B, all students required approximately 15 to 35 minutes to take each test. Monitoring the administration of the test was the usual procedure used by Teacher A and Teacher B. Both walked around and to the back of the classroom as students took their tests; this is an expected testing procedure at our school.

Students who were absent on any given test day did not have their test score used in the study. In order to maintain the integrity of the study, the scores included in this study were only those given on the day of the test during the period they are assigned. Make-up tests for students taking tests during their lunch period, or in the afternoon, or during study hall may have compromised the data and possibly the results of this study.

#### Statistical Analysis

The independent variables in this study were gender, preferred learning time, and time of day, which was morning for those students in the morning classes and afternoon for those students in the afternoon classes. Students did not change groups. A three-way analysis of covariance (ANCOVA) statistical test was used. The ANCOVA procedure analyzed the mean composite score from the technology-related class tests to determine if there was an interaction between gender, preference, and time of day controlling for influence of a student's Individual Education Plan (IEP), Teacher, and students' prior technology course average. Two-way interactions for time of day and preference were analyzed along with main effects for time of day, preference, and gender. There was two levels within each factor. It is assumed that gender, learning preference, and time of day

influenced test scores. The SPSS statistical package was used for reporting significance,  $p < .05$ , by analysis of interactions and effects.

The Factorial ANCOVA general linear model procedure was used to determine interactions while controlling for covariates. The dependent variable was one composite average consisting of up to seven end-of-unit technology test scores, where each student took an average of three of these tests. The covariate was the students' previous technology course final average from middle school, individualized educational plan, and teacher. Independent variables were class time, learning preference, determined from the MESC instrument, and gender. No transformations of data were necessary. Several examinations of the data were conducted on the data using SPSS, and all  $p$  values report at the a priori level of .05, using two-tailed tests.

Procedure for Hypothesis 1--the mean scores for afternoon matched male students will be significantly higher than those mean scores for the morning matched male students—used a three way interaction for gender, time of day, and preference. An interaction was used to determine the effect one variable depended on the others, or how the interaction of two variables depended on the other. Results of analyzing one factor at a time would have been misleading for this hypothesis.

Procedure for Hypothesis 2—the mean scores for students who are tested during their preferred learning time will be significantly higher than those mean scores for students who are not tested during their preferred learning time—used an interaction of class time and a student's learning preference as revealed in the student's MESC score. The procedure was appropriate to reveal if students' scores depended on their preferred learning time. Results of analyzing one factor at a time would have been misleading for this hypothesis.

Procedure for Hypothesis 3—there are significant differences between morning and afternoon learners regardless of time of day—used a between subjects main effect to compare differences between morning and afternoon learners, which was determined by the MESOC instrument. Results of analyzing one factor looking for a statistically significant main effect was appropriate for this hypothesis.

Procedure for Hypothesis 4—there are significant differences between morning and afternoon classes regardless of gender—used a between subjects main effect to compare differences between time of day, either morning or afternoon. Results of analyzing one factor looking for a statistically significant main effect was appropriate for this hypothesis.

## CHAPTER IV

### RESULTS

#### Introduction

The researcher's primary purpose was to examine matching and mismatching of learning preference and time of day. This research hypothesized that gender, learning preference, and time of day, along with interactions, influenced test scores, and therefore; these three, gender, learning preference, and time of day, were the independent variables used in this study. Each of these factors contained two levels. A three-way analysis of covariance (ANCOVA) statistical test was used to analyze the interaction between gender, preference, and time of day controlling for influence of a student's Individual Education Plan (IEP), Teacher, and students' prior technology course average. Two-way interactions for time of day and preference were analyzed along with main effects for time of day, preference, and gender.

#### Findings

This quasi-experimental study examined 162 technology students, from intact groups taught by two different technology teachers. The dependent variable will be the composite average score drawn from seven end-of-unit standardized tests. This study investigated the relationships among achievement and time of day preference under conditions in which test administration was matched and mismatched with each student's individual learning preference as measured by the Morningness-Eveningness Scale for Children (MESC) instrument (Carskadon et al., 1993). Covariates were used to control for and partial out the influence of students' prior technology course average, Individualized Educational Plan (IEP), and teacher. From a total population of 169 students, 162 participated as seven students either did not return parental permission,

transferred to another block class, moved, got transferred to an alternate school setting, or received a special education ruling during the term which prevented them from participating in the study.

There were three independent variables--gender, time of day, and learning preference; one dependent variable--composite average of the technology tests; and three covariates--the students' final average score from their prior technology course, teacher, and Individual Education Plan. Students took Computer Discovery in the 8<sup>th</sup> grade.

The first independent variable was gender, which provided an appropriate, although not equal, sample selection for comparing males and females: males (56.2%) and females (43.8%). The second independent variable was the time of day the test was administered. Tests administered in the morning were given between 7:45 a.m. and 11:04 a.m. Tests administered in the afternoon were given between 12:11 p.m. and 3:01 p.m.

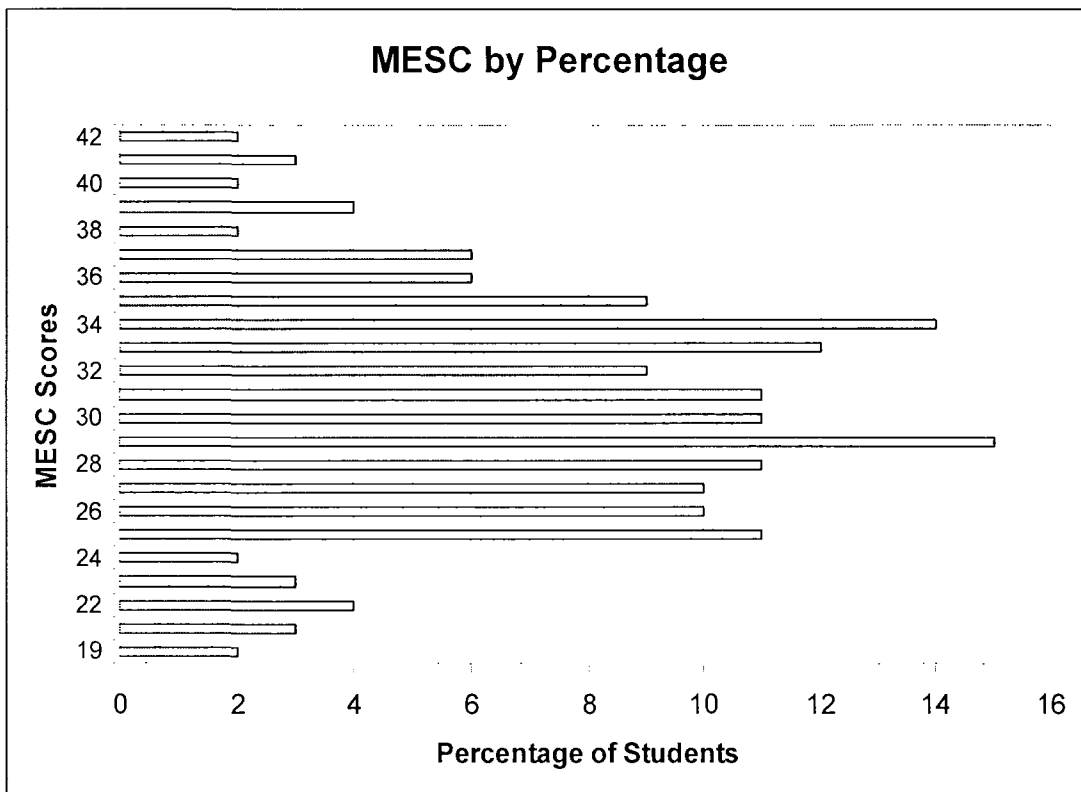
The third independent variable was the score obtained from the MESC instrument (Carskadon et al., 1993). Chronbach's alpha showed a .75 internal reliability. These scores, which could range from 10 to 42, revealed the students learning preference time. The item analysis shown in Table 1 detailed the preference count along with the cumulative percentage. These students' sample scores ranged from 19 to 42, and as shown in Figure 2, the results looked somewhat like a bell-curve distribution. The mode was 29, the average and median were 31; the exact half-way point between the low score 19 and the high score 42. A mean split was therefore used to score the teens as morning or afternoon. A split was followed by dichotomizing and coding the MESC scores 0 or 1. The mean split provided the natural division of the students' preference: morning 49.4% and afternoon 50.6%. Because two categories were needed (morning and afternoon) the

MESC scores were dichotomously coded 1 and 0 respectively, for below 30 (afternoon preference) and 30 and above (morning preference).

Table 1

*Item Distribution and Count of Morningness/Eveningness Results*

MESC Item Analysis		
Scores	Percentage	Cumulative Percentage
19	2	1
21	3	2
22	4	5
23	3	7
24	2	8
25	11	15
26	10	21
27	10	27
28	11	34
29	15	43
30	11	50
31	11	57
32	9	62
33	12	69
34	14	83
35	9	87
36	6	91
37	6	92
38	2	94
39	4	94
40	2	95
41	3	97
42	2	99
Totals	N=162	100



*Figure 1.* Morningness/Eveningness Item Analysis Graph



The dependent variable was the composite average score of each student's end-of-unit, standardized tests. Not all students completed seven tests. Students who were absent on the day of the test, were given the test for class purposes, but for the purpose of this study were not included in this study. In addition to not returning parental permission, one student had a schedule change, two students transferred to alternative school, two students received special education rulings during the semester; these were some reasons that all students did not complete all tests. Also, students in block classes were further in the curriculum; and therefore, did not take the same unit tests as students in traditional period classes took. All students in this analysis took at least two tests; average tests taken by each student was three. The tests were end-of-unit standardized technology tests on Excel, PowerPoint, Publisher, and Access.

Frequencies for IEP, gender, class time, teacher, and preference appeared within expected ranges, and all data appeared valid. The total sample was 162 students. The mean of the students' learning preference was 31. The median was 31. While the MESC instrument provided a possible range of scores from 10 to 42, in this sample, students' scores varied from a minimum of 19 to a maximum of 42. The high MESC preference scores indicated a very strong morning learner. Along the lowest end of the MESC preference range, the scores indicated a learner preferring to learn later in the day. No students in this sample assessed with a learning preference in the 10-18 score range. Therefore, no student in this sample presented in the extreme of being a late (evening) learner.

The mean split divided the students into morning or afternoon learners as noted through the frequencies reported in Table 2. A mean split was used to divide the students into morning or afternoon learning preference groups. All subjects who scored below the

mean were assigned the number 1 for afternoon learners and all subjects scoring above the mean were assigned the number 0 for morning learners. These dummy codes of 0 and 1 are commonly used to categorize two groups. Students were almost evenly split according to morning (49.4%,  $n=82$ ), and afternoon learners (50.6%,  $n=80$ ); however, the majority (87 students or 53.7% of this sample) are in a morning technology class. Students were evenly dispersed between teacher A (81 students) and teacher B (81 students). Both teachers taught four sections of this technology class, for a total of eight sections. Both teachers' enrollment for each class ranged from 15 to 26 students per class, with an average class enrollment of 22 students. A large number of students, as expected, did not require an Individualized Education Plan (IEP).

Table 2

*Frequency and Percentage Distribution of IEP, Gender, Class Time, and Preferred Learning Time by Teacher*

		Teacher A			Teacher B			TOTAL (%)
		AM	PM	%	AM	PM	%	
IEP	Yes	7	5	0.2	7	1	0.1	20 (12.3)
	No	37	31	0.8	38	36	0.9	142 (87.7)
Gender	M	23	17	0.5	28	23	0.6	91 (56.2)
	F	22	20	0.5	17	13	0.4	71 (43.8)
Pref	AM	24	20	0.5	20	16	0.4	80 (49.4)
	PM	22	15	0.5	23	22	0.6	82 (50.6)

Table 3 shows descriptives of the average of their technology test scores and previous technology course average, which was their final average at the end of their 8<sup>th</sup> grade Computer Discovery course. The skewness statistic for the prior technology average was -4.39, and the skewness statistic for their average score was -5.64. While both revealed a skewness problem, a visual inspection of the data confirmed that the data points of interest were in fact real test scores; therefore, transforms of data were not necessary because the scores were valid.

Table 3

*Descriptives of Prior Technology Course Average and Composite Average of Tests*

	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
Tech Avg.	50.00	100.0	86.09	11.27	-.87 .20	1.26 .37
Test Avg.	39.50	96.75	79.30	10.62	-1.06 .19	.32 .40

In order to test for homogeneity an SPSS model that included the interaction of each factor--gender, time of test delivery, learning preference by covariates--individualized education plan, teacher, prior technology course average was used to test whether the correlations were equal for all conditions. The ANCOVA assumption of homogeneity of regression slopes was violated for only one of the 23 factor-by-covariate interactions. The interaction of Individualized Education Plan (IEP) status and time of day was significant, but with only 13% of the students in the analysis with an individualized education plan, this violation, due to small sample size; one heterogeneous interaction was not of particular interest and did not impede further analysis.  $F(1,133)=50.02, p=.00$ ). Effect size was not calculated because of unequal sample size.

An analysis of covariance variance was conducted for male students to determine if there were significant differences when tested during their preferred learning time, controlling for students' prior technology score. Levene's Test of Equal Variances was not significant (.37), indicating the assumption of homogeneity of variances assumption had been met.

### Statistical Analysis of Hypotheses

#### *Statistical Analysis of Hypothesis 1*

1. The mean scores for afternoon matched male students will be significantly higher than those mean scores for morning matched male students.

Table 4 presents results of the three-way ANCOVA. For gender, time of day and preference the scores for the afternoon matched male students were not statistically significantly different than those for morning matched students, when controlling for their prior technology course average. While males' scores were higher when tested in the afternoon ( $M=81.9$ ,  $SE=1.5$ ), females' scores were not ( $M=78.5$ ,  $SE=1.4$ ). The interaction of time of day, gender, and preferred learning time was not statistically significant.  $F(1,133)=.77$ ,  $p=.38$ ,  $r=.08$ .

Table 4

*Three-Factor ANCOVA by Gender and Time of Day and Preferred Learning Time*

Source	SS	Df	MS	F	Sig.
Corrected Model	8129.24	10	812.92	12.72	.00
Intercept	4464.99	1	4464.99	69.86	.00
Teacher	17.77	1	17.77	.28	.60
Individualized Educational Plan	3197.09	1	3197.09	50.02	.00
Prior Technology Course average	1879.72	1	1879.72	29.41	.00
Time of day	18.78	1	18.78	.29	.59
Gender	225.14	1	225.14	3.52	.06
Preference	339.49	1	339.49	5.31	.02
Time of day * Gender	252.40	1	252.40	3.95	.05
Time of day * Preference	106.58	1	106.58	1.67	.20
Gender * Preference	1.52	1	1.52	.02	.88
Time of day * Gender * Preference	49.33	1	49.33	.77	.38
Error	8500.11	133	63.91		
Total	909142.55	144			
Corrected Total	16629.35	143			

### *Statistical Analysis of Hypothesis 2*

2. The mean scores for students who are tested during their preferred learning time will be significantly higher than those mean scores for students who are not tested during their preferred learning time.

The test of between-subjects effects in Table 4 shows preference according to class time. The interaction of learning preference and time is the row of interest for this hypothesis. The interaction of class time and a student's learning preference does not influence or make a difference in their average. The average for students who are tested during their preferred learning time was not statistically significant when compared to those students who are not tested during their preferred learning time as determined by their learning preference:  $F(1,133)=1.67, p=.20, r=.11$ .

### *Statistical Analysis of Hypothesis 3*

3. There are significant differences between morning and afternoon learners regardless of time of day.

A test of between-subjects effects in Table 4 shows a main effect when comparing morning and afternoon learners. An analysis of differences between morning and afternoon classes regardless of gender shows a significant difference,  $F(1,133)=5.31, p=.02, \eta^2=.02, r=.20$ .

Table 5 shows marginal means of learning preference according to intact Class Time groupings. Four groups are shown: morning students matched according to their learning preference ( $\bar{X}=77.0$ ), morning students mismatched according to their learning preference of afternoon ( $\bar{X}=81.4$ ), afternoon students matched according to their learning preference ( $\bar{X}=79.1$ ), and afternoon students mismatched according to their learning preference of morning ( $\bar{X}=77.5$ ) This mean stated that the morning matched

students, those who prefer to learn in the morning and are scheduled in the morning technology classes, scored higher when tested in the afternoon. Morning students tested during their preferred learning time reflected the lowest mean of the four groups ( $\bar{X}=77.0$ ). For the morning learner, testing in the afternoon was more advantageous than matching them with their morning learning style. Morning learners, even when their learning preference was matched did not score better than their afternoon counterparts.

The comparison of morning learner ( $\bar{X}=77.5$ ) and afternoon learner ( $\bar{X}=80.2$ ) showed the afternoon learner outscored the morning learner. Students in either afternoon classes or those students preferring afternoon learning outscored students who have no afternoon element included in their learning style.

Also noted in the means shown in Table 5, the overall average of the morning test scores ( $\bar{X}=79.2$ ) is raised by the afternoon learners' scores. The overall average of the morning learner ( $\bar{X}=77.5$ ) is raised when morning learners are tested in the afternoon.

Table 5

*Estimated Marginal Means of Class Time and Preferred Learning Time*

Class Time	AM Learner	PM Learner	Average
AM	77.0	81.4	79.2
PM	77.9	79.1	78.5
Average	77.5	80.2	



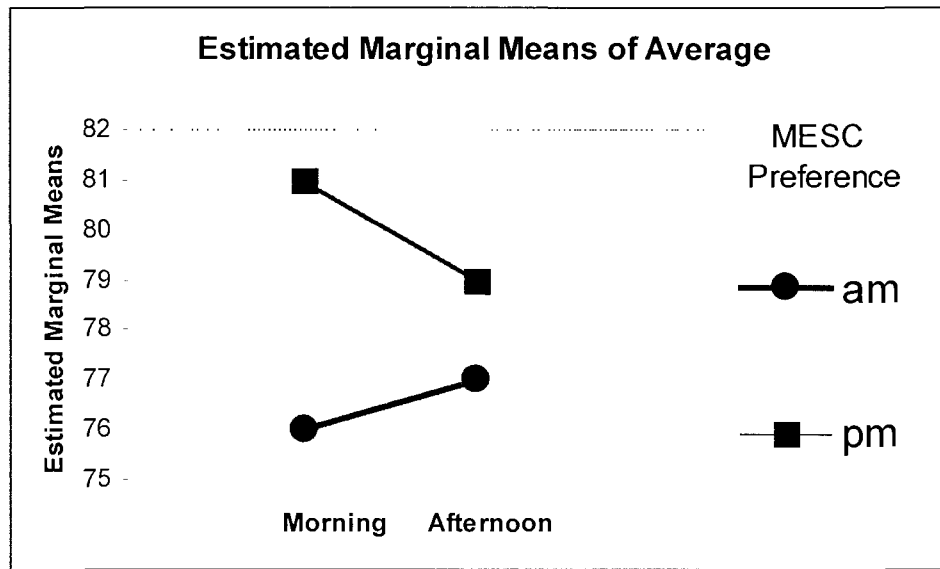


Figure 2. Estimated Marginal Means of Class Time and Preferred Learning Time

#### *Statistical Analysis of Hypothesis 4*

4. There are significant differences between morning and afternoon classes regardless of gender.

A test of between-subjects effects (Table 4) shows no main effect when looking at time of day. An analysis of differences in time of day regardless of gender shows no significant difference,  $F(1,133)=.29, p=.59, r=.05$ . The main effect was not significant.

#### Summary of Hypotheses

This study examined a three-way interaction or variation between and within groups of variables and did not predict performance. The three-way analysis of covariance statistical method examined interaction between three independent variables--gender, time of day, and preference on one dependent variable, the students' average score, controlling for students' prior technology average from middle school, individualized educational plan, and teacher.

1. The mean scores for afternoon matched male students will be significantly higher than the mean scores for morning matched male students.

The mean scores for afternoon matched male students were not significantly higher than those mean scores for morning matched male students; therefore, with no significant differences hypothesis 1 was rejected.

2. The mean scores for students who are tested during their preferred learning time will be significantly higher than those mean scores for students who are not tested during their preferred learning time.

The mean scores for students who are tested during their preferred learning time were not significantly higher than those mean scores for students who are not tested during their preferred learning time. Matching time of day and learning preference resulted in no statistical difference. Therefore, with no significant differences hypothesis 2 was rejected.

3. There are significant differences between morning and afternoon learners regardless of time of day.

There was a significant difference between morning and afternoon learners regardless of time of day; therefore, with significant statistical findings hypothesis 3 was supported. There was evidence of a relationship between learning preference. There is a significant difference in test scores depending on whether the student is an afternoon learner or a morning learner. Therefore, with significance differences between morning and afternoon learners, hypothesis 3 was supported.

4. There are significant differences between morning and afternoon classes regardless of gender.

There were no statistically significant differences between morning and afternoon classes regardless of gender; therefore, with no significant differences hypothesis 4 was rejected.

## CHAPTER V

### SUMMARY AND CONCLUSIONS

#### Purpose

This researcher investigated effects of students' technology class average, which consisted of an average, composite score, of their technology tests when compared to their class time, morning or afternoon, and matched according to their preferred learning time as measured by the MESC (Carskadon et al., 1993) instrument. The subjects were technology students from two different technology teachers' classes at the same high school. Covariates were teacher, whether students had an Individualized Educational Plan, and previous technology course average. The purpose was to examine relationships about time of day and learning preference of high school students. The goal was to provide information about morning and afternoon learning and learning preference as related to high school students' best time to test.

#### Summary of the Procedure

This was a study of 162 technology students from a level 5, local blue-ribbon high school. The students were from two different technology teacher's classes teaching the same course. Students did not change groups, and each teacher had both morning and afternoon classes. All participation was voluntary.

Data were gathered using the Morningness-Eveningness Scale for Children (MESC) (Carskadon et al., 1993). The 10-item questionnaire determines a learning preference based on questions about learning, sleeping, and waking behavior. The independent variables were gender, preferred learning time (MESC), and time of day. The dependent variable was the composite average of students' technology tests. Covariates were prior technology course average, teacher, and whether or not the student

had an Individualized Education Plan as deemed by a special education ruling. The ANCOVA procedure was used to test the hypotheses of this study, and the SPSS statistical package was used for reporting significance at an alpha level of .05.

### Conclusions

Based on this study, the two original research questions were answered:

1. Is there a variation in test scores of students who are matched with time of preference and testing time when compared to students who are mismatched with time of preference and testing time?

For the 162 students, a slight majority preferred learning in the afternoon; however, there was no statistically significant difference in scores when comparing students who were matched and mismatched according to their learning preference and time of day tests were given.

2. Does gender cause a different interaction when time of day and preference are matched?

For the 162 students, there was no statistically significant difference in scores in this interaction according to gender when students were matched and mismatched with learning preference and time of day tests were given.

Based on this study the hypotheses presented as follows:

Hypothesis 1. The mean scores for afternoon matched male students will be significantly higher than those mean scores for morning matched male students.

The mean scores for afternoon matched male students were not statistically significantly higher than those mean scores for morning matched male students.

Hypothesis 2. The mean scores for students who are tested during their preferred learning time will be significantly higher than those mean scores for students who are not tested during their preferred learning time.

The mean scores for students who were tested during their preferred learning time were not statistically significantly higher than those mean scores for students who were not tested during their preferred learning time.

Hypothesis 3. There are significant differences between morning and afternoon learners regardless of time of day.

There were statistically significant differences between morning and afternoon learners regardless of time of day. There was evidence of a relationship between learning preference. There was a significant difference in test scores depending on whether the student was an afternoon learner or a morning learner.

The means of this hypothesis showed that an afternoon component in adolescent learning increased scores. Four groups—1) morning students matched according to their learning preference ( $\bar{X}=77.0$ ), 2) morning students mismatched according to their learning preference of afternoon ( $\bar{X}=81.4$ ), 3) afternoon students matched according to their learning preference ( $\bar{X}=79.1$ ), and 4) afternoon students mismatched according to their learning preference of morning ( $\bar{X}=77.5$ ) showed that these subjects, high school students, scored best when an afternoon component was included in their learning. Those morning students who were morning learners reflected the lowest mean of the four groups ( $\bar{X}=77.0$ ). All other groups had at least one afternoon learning component—either they were in an afternoon class or they presented with an afternoon learning style.

Morning learners, even when their learning preference was matched did not score better on tests than their afternoon counterparts. The comparison of morning learner

( $\bar{X}=77.5$ ) and afternoon learner ( $\bar{X}=80.2$ ) showed the afternoon learners outscored the morning learners. Students in either afternoon classes or morning learners who preferred afternoon learning outscored students who have no afternoon element included in their learning style, i.e. morning learners with a morning learning preference. Perhaps matching time and preference is not as important as including some type of afternoon component.

Hypothesis 4. There are significant differences between morning and afternoon classes regardless of gender.

There were no statistically significant differences between morning and afternoon classes regardless of gender.

#### Limitations

This study was limited as follows:

1. The students' learning preference was self reported using the 10-item Morningness-Eveningness Scale for Children (MESC) (Carskadon et al., 1993). There was no measurement of the effect of consistency at individual student levels. A student's selection could have limitations under the condition of the observer's frame of reference. For example, a student could have rushed through the questionnaire in an effort to complete (although this was not noticed), or perhaps a student was not serious minded in the self report and selected a less appropriate answer. Chronbach's alpha was .75; therefore, this researcher was satisfied with the overall internal reliability.

2. There was no way to assess, using the MESC scale, those who may not have one learning preference. Nor could this research support or refute Dunn's (1993) statement that gifted learners can learn at any time of the day because this study did not account for those learners who were gifted or enrolled in advanced placement classes.

Without this data, an unknown percentage of students in the study had no statistical control.

3. There was the lack of control for unknown variables that may have influenced test scores. Dunn (1995) reported that matching learning preference would result in different gains for underachievers, average performers, and achievers. This study could not distinguish different achieving groups.

4. The use of a mean-split in determining learning preference meant that a  $\pm 1$  point difference at the 30/31 split, would make the difference in determining a morning learner or an afternoon learner. A tertile split was considered but not chosen, as the groups did not lend themselves to quartile divisions. Because there was a need to distinguish between two groups, morning and afternoon, a mean split was chosen.

5. Data was only collected during the Spring 2009 semester.

6. Morning schedules for morning students were not identical. Teacher A's morning students were tested between 8:38 and 11:04 and Teacher B's morning students were tested between 7:45 and 9:26. Afternoon schedules for afternoon students were not identical. Teacher A's afternoon students were tested between 11:45 and 2:08 while Teacher B's afternoon students were tested between 1:20 and 3:01. Therefore, Teacher B's morning population of students may have been tested 45 minutes earlier than Teacher A's morning population students, subsequently Teacher A's later morning students could have tested as much as 45 minutes later than Teacher B's students.

This was perhaps somewhat limiting because much research about adolescents circadian rhythms (Sousa, 2003; *School Mornings Too Early For Studying Teens*, 2008) report the critical early hours in the day being 1 – 2.5 hours as the worst learning time, and Sylwester (2007) stated that high school should not begin before 9 a.m. While this



study contained one class from eight sections being tested between 7:45 and 8:30, this study did not analyze or account for those students' scores differently than those morning students tested between 8:30 and 11:04.

7. Other variables such as tutoring, after school remediation, and test delivery methods were not included or accounted for, but according to Dunn and Dunn (1993) and Carskadon (1999) could serve as barriers or boosters to student learning.

### Discussion

This study found that when a student has an afternoon component in their learning style they scored better than matched and mismatched by time of day and preference. Students in the afternoon classes with morning learning preference scored better than students in the morning classes with morning preferences is an indicator that an afternoon component in learning outweighs the benefit of matching morning learners with their preference. The students in the afternoon class, while not matched with their learning preference, were probably more alert which gave them a cognitive advantage in testing.

Earlier research emerging since the dawn of the 21<sup>st</sup> century (Dunn, 1998; Carskadon, 1999), was guided by two assumptions that 1) adolescents learn best when matched with their preferred learning time and 2) adolescents do not learn best early in the day. In this sample of 162 high school students as shown though this study's statistical analysis, afternoon is a better time for teens to learn regardless of their preference.

This study was not able to support findings of other research on matching and mismatching time of day with preference such as Goldstein et al. (2006), Callan (1995) and Hasher et al. (2005). However, this research supported that of Dunn and Dunn, (1993) along with Wolfson and Carskadon (1998), Callan (1998), and Carskadon (1999)

which stated that that morning is not an adolescent's best learning time. This study could not support matching and mismatching learning and time of day; as noted by Wrobel (1999) and Virostoko (1983) who stressed the need to match time of day tested with students' preferred time to learn.

While learning is collective, the psyche of learning brings together elements that cannot be divided or discriminated (Jung, 1954). But this study supports the relationship between afternoon learning and the adolescent, because according to average scores, those subjects with an afternoon learning component outscored students who had no afternoon learning component. An association or correlation or prediction about learning is subject to interpretation of many intervening factors, and perhaps this research can encourage further exploration of afternoon learning as a component of adolescent biology.

An extremely interesting point in this analysis was not the matching or mismatching of a student's learning preference and time of day, but rather whether students had an afternoon component to their learning. In other words, the biology of adolescent learning, or rather the circadian biology of the adolescent, presented over time of day. The measurement of these teens showed no association between learning and matching and mismatching time of day, but an internal disassociation, that of biological predispositions of the teen, was noted when morning learners during the morning scored the lowest.

The rationale may be that an adolescent's biology of being more alert later in the day and the adolescent's circadian rhythm is a learning style within itself—and in combination with teens' other secondary learning styles (Dunn & Dunn, 1979)—creates a

physiological effect on cognitive processing of adolescents that works differently later in the day.

### Recommendations for School Districts

Adolescent students who are tested in the afternoon, regardless of their time-of-day learning style scored higher on tests. The afternoon adolescent is probably more awake and therefore more cognitively able to perform learning tasks. While research supports a delayed school starting time, perhaps schools even if they do not start school later should, when possible, administer standardized tests, ACT, SAT, exit exams, and subject-area tests later in the day. Because this study showed that learners with no afternoon component in their learning style scored the lowest among their peers, counselors, teachers, instructional leaders, principals, and other educational stakeholders should 1) consider the benefit of beginning high school later in the morning 2) consider administering subject-area tests, ACT, SAT, and exit exams later in the day. Although revising bell schedules could perhaps conflict with the lunch rotation for that day, the break schedule, classes and/or any other tightly scheduled event, research (Carskadon, 1999; Sylwester, 2007; Callan, 1998; Dunn & Dunn, 1993; and Carskadon, 1999) on the benefits of academic achievement by delaying high school starting times from 30 minutes to 2.5 hours has been successful in recently persuading over 200 high schools in the United States to change their high school starting times. This study supports that the morning component of learning without an afternoon component resulted in lower academic achievement among the teens in this study.

Unfortunately, teens must be scheduled in early morning classes. Schools only control placement not learning preference. While the target to consider are those morning

students who prefer morning learning, these teens could perhaps have their most challenging course scheduled in the afternoon.

#### Recommendations for Future Studies and Research

Based on this study, future researchers are recommended to consider and further explore testing and the adolescent student. Future researchers should replicate the study with early morning learners as compared to late morning learners. Carskadon's (1999) and Sousa's (2003) statement that the adolescent's biology is a strong indicator of the adolescent's cognitive functioning or learning should be explored further. This research supported that adolescence is a time when biological circadian rhythms in teens cause cognitive delay, and that perhaps high schools should delay starting time because of teens' chronology (Callan, 1998; Dunn, 1993; Sousa, 2003).

Because many colleges extend acceptance letters and award scholarships based on ACT and SAT scores, researchers should study the effects and differences in administering ACT and SAT in the afternoon. Typically these tests are scheduled early in the day, where those students with a morning learning preference (or without the afternoon learning component) would be at a disadvantage. Replicate the study with a larger sample size from the state of Mississippi. Repeating the study would perhaps support that many teens may be academically challenged when required to test early in the morning. Also, if more studies confirmed that teens score better on tests when they have an afternoon component to learning then results of these studies would be generalizable to the population. Thus future researchers and educators could adopt procedures to determine their students' learning preference, resolving to include an afternoon component for those who are morning learners in morning classes.

A study should be conducted to determine the attitudes of district superintendents and principals toward testing in the afternoon to identify barriers to school scheduling, knowledge of adolescent circadian rhythms and learning. While accounting for differences in students' afternoon and/or morning learning components may be a new concept for educators, according to this study is noteworthy.

Future researchers should isolate the afternoon component to high school achievement. According to this study, when students have an afternoon component to learning they score higher. Because tests are cognitively demanding, a certain level of alertness must be present if students are to test well. Many researchers have recognized alertness and time of day as predictors in adolescent learning. Leading sleep researcher, Carskadon et al. (1993) who designed the MESC instrument, through her research, accounts for this afternoon difference at the high school level through her studies of the biology of the adolescents' sleep/wake cycle. Notwithstanding it is possible other unknown factors, such as nutrition, health, mental state may influence teens' performance in the morning because their level of alertness and concentration is minimized due to their biology at this time of day.

Future researchers should perhaps research and study the effect of morning tutoring and afternoon tutoring in increasing student achievement. Generally, most tutoring occurs in the afternoon. Is this because the tutoring increases the achievement or is it the interaction of afternoon and tutoring?

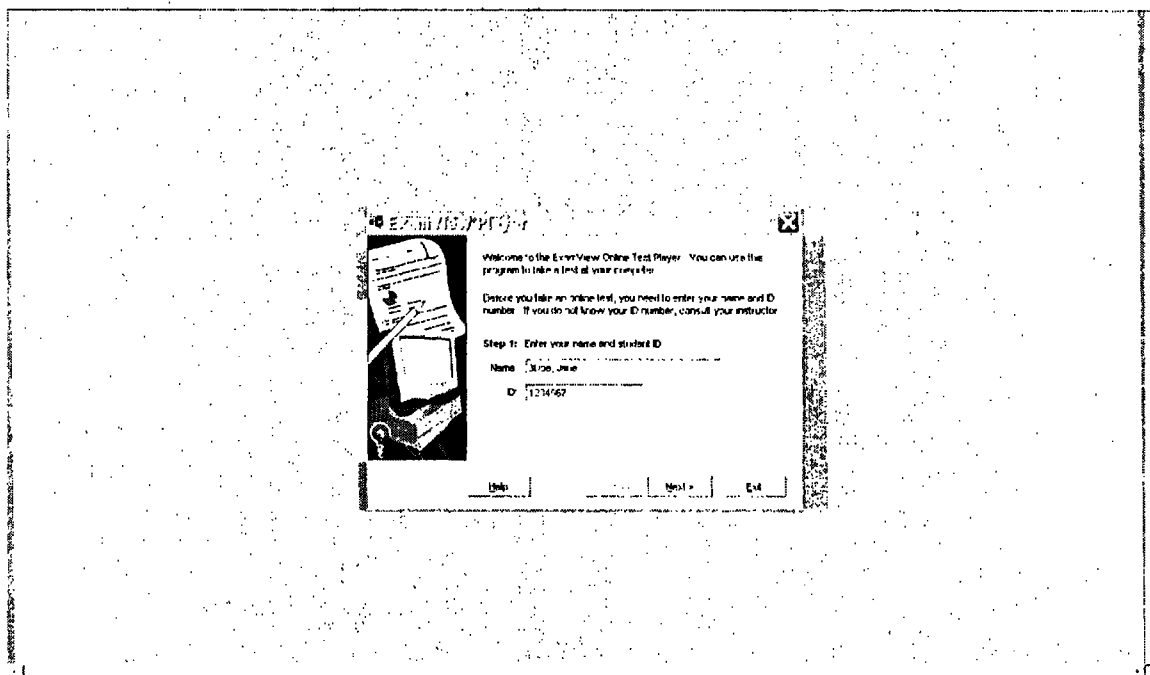
## APPENDIX A

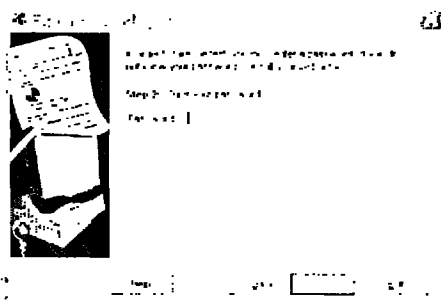
## TECHNOLOGY CLASS SCHEDULES BY TEACHER

Technology Class A Spring 2009			
Morning periods		Afternoon periods	
2	3	4	5
8:38 – 9:26	9:31 – 11:04	11:11-11:41  Lunch:  11:41 – 12:11  12:11 – 1:15	1:20-2:08



Technology Class B Spring 2009			
Morning periods		Afternoon periods	
1	2	5	6
7:45 – 8:33	8:38 – 9:26	1:20-2:08	2:13-3:01

## APPENDIX B

EXAMVIEW PLAYER: SECURE LOGIN, TEST QUESTION, AND TEACHER  
RESULTS





...  

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

1. You should never have negative numbers on the worksheet.





- ☐ a. true  
☐ b. false

Answer

Help Go To End

Downward arrows 27

Question 1 of 27

Database Test 2nd & 5th  
All  
TEST SCORES

11/10/2000

ID	Score (out of 33)	% Correct
000424333	29	85%
000258384	28	85%
000258319	28	85%
000646716	27	82%
000228712	27	82%
000258778	26	79%
000258403	25	76%
000430883	24	73%
000258358	24	73%
000611070	24	73%
001009259	23	70%
000258628	22	67%
000258622	22	67%
000258607	22	67%
000664107	21	64%
000424371	21	64%
000228720	21	64%
000258695	21	64%
000258540	20	61%
000258345	19	58%
000229024	18	55%
000424784	17	52%
000424533	13	39%
000258904	9	27%
000424453	-	-
000197625	-	-
000110014	-	-
000424201	-	-
000424133	-	-
000424774	-	-
000424664	-	-
000258374	-	-
000424528	-	-
000197378	-	-
000258421	-	-
000258474	-	-
000258800	-	-
000258039	-	-
000158750	-	-
000763792	-	-
000424117	-	-
000424018	-	-
000460812	-	-
000424072	-	-

Report: Test Scores (ID only)

Sort by: Percent correct

Print

Close

## APPENDIX C

## MESG WITH SCORING CODE

- \_\_\_\_\_1)\* Imagine: School is canceled! You can get up whenever you want to. When would you get out of bed? Between ...
- a) 5:00 and 6:30 am
  - b) 6:30 and 7:45 am
  - c) 7:45 and 9:45 am
  - d) 9:45 and 11:00 am
  - e) 11:00 am and noon
- \_\_\_\_\_2) Is it easy for you to get up in the morning?
- a) No way!
  - b) Sort of
  - c) Pretty easy
  - d) It's a cinch
- \_\_\_\_\_3)\* Gym class is set for 7:00 in the morning. How do you think you'll do?
- a) My best!
  - b) Okay
  - c) Worse than usual
  - d) Awful
- \_\_\_\_\_4)\* The bad news: You have to take a two-hour test. The good news: you can take it when you think you'll do your best. what time is that?
- a) 8:00 to 10:00 am
  - b) 11:00 am to 1:00 pm
  - c) 3:00 to 5:00 pm
  - d) 7:00 to 9:00 pm
- \_\_\_\_\_5)\* When do you have the most energy to do your favorite things?
- a) Morning! I'm tired in the evening
  - b) Morning more than evening
  - c) Evening more than morning
  - d) Evening! I'm tired in the morning
- \_\_\_\_\_6)\* Guess what? Your parents have decided to let you set your own bedtime. What time would you pick? Between ...
- a) 8:00 and 9:00 pm
  - b) 9:00 and 10:15 pm
  - c) 10:15 pm and 12:30 am
  - d) 12:30 and 1:45 am
  - e) 1:45 and 3:00 am
- \_\_\_\_\_7) How alert are you in the first half hour you're up?
- a) Out of it
  - b) A little dazed
  - c) Okay
  - d) Ready to take on the world
- \_\_\_\_\_8)\* When does your body start to tell you it's time for bed (even if you ignore it)? Between ...
- a) 8:00 and 9:00 pm
  - b) 9:00 and 10:15 pm
  - c) 10:15 pm and 12:30 am
  - d) 12:30 and 1:45 am
  - e) 1:45 and 3:00 am
- \_\_\_\_\_9) Say you had to get up at 6:00 am every morning: What would it be like?
- a) Awful!
  - b) Not so great
  - c) Okay (if I have to)
  - d) Fine, no problem
- \_\_\_\_\_10)\* When you wake up in the morning how long does it take for you to be totally "with it?"
- a) 0 to 10 minutes
  - b) 11 to 20 minutes
  - c) 21 to 40 minutes
  - d) More than 40 minutes

Morningness/eveningness scale for children. A score is derived by adding points for each answer: a=1, b=2, c=3, d=4, e=5, except as indicated by \*, where point values are reversed. The maximum score is 42 (maximum morning preference) and the minimum is 10 (minimal morning preference).

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Carskadon, M., Vieira, C., & Acebo, C. (1993). Association between puberty and delayed phase preference. *Sleep*, 16(3), 258-262.

## APPENDIX D

## MESC AS GIVEN TO STUDENTS

NAME \_\_\_\_\_ PERIOD \_\_\_\_\_

- \_\_\_\_\_ 1) Imagine: School is canceled! You can get up whenever you want to. When would you get out of bed? Between ...
- a. 5:00 and 6:30 am
  - b. 6:30 and 7:45 am
  - c. 7:45 and 9:45 am
  - d. 9:45 and 11:00 am
  - e. 11:00 am and noon
- \_\_\_\_\_ 2) Is it easy for you to get up in the morning?
- a. No way!
  - b. Sort of
  - c. Pretty easy
  - d. It's a cinch
- \_\_\_\_\_ 3) Gym class is set for 7:00 in the morning. How do you think you'll do?
- a. My best!
  - b. Okay
  - c. Worse than usual
  - d. Awful
- \_\_\_\_\_ 4) The bad news: You have to take a two-hour test. The good news: you can take it when you think you'll do your best. what time is that?
- a. 8:00 to 10:00 am
  - b. 11:00 am to 1:00 pm
  - c. 3:00 to 5:00 pm
  - d. 7:00 to 9:00 pm
- \_\_\_\_\_ 5) When do you have the most energy to do your favorite things?
- a. Morning! I'm tired in the evening
  - b. Morning more than evening
  - c. Evening more than morning
  - d. Evening! I'm tired in the morning
- \_\_\_\_\_ 6) Guess what? Your parents have decided to let you set your own bedtime. What time would you pick? Between ...
- a. 8:00 and 9:00 pm
  - b. 9:00 and 10:15 pm
  - c. 10:15 pm and 12:30 am
  - d. 12:30 and 1:45 am
  - e. 1:45 and 3:00 am
- \_\_\_\_\_ 7) How alert are you in the first half hour you're up?
- a. Out of it
  - b. A little dazed
  - c. Okay
  - d. Ready to take on the world
- \_\_\_\_\_ 8) When does your body start to tell you it's time for bed (even if you ignore it)? Between ...
- a. 8:00 and 9:00 pm
  - b. 9:00 and 10:15 pm
  - c. 10:15 pm and 12:30 am
  - d. 12:30 and 1:45 am
  - e. 1:45 and 3:00 am
- \_\_\_\_\_ 9) Say you had to get up at 6:00 am every morning: What would it be like?
- a. Awful!
  - b. Not so great
  - c. Okay (if I have to)
  - d. Fine, no problem
- \_\_\_\_\_ 10) When you wake up in the morning how long does it take for you to be totally "with it?"
- a. 0 to 10 minutes
  - b. 11 to 20 minutes
  - c. 21 to 40 minutes
  - d. More than 40 minutes

## APPENDIX E

## AUTHOR'S PERMISSION TO USE

**Close Re: Children's Morningness & Eveningness Preference Instrument**

Sent By: "Mary\_Carskadon" <mary\_carskadon@brown.edu> On: Nov 11/22/08 1:35 PM

To: "leishaparker" <leishaparker@comcast.net>

Download all attachments as zip file

Roenneberg kJMBR2003.pdf (165.3 KB, download) P

Online-Morningness1989.pdf (936 KB, download) C

Hi Leisha.

There is no cost to use the scale. You can just put the items from the published instrument into your form.

On the other hand, you might want to consider whether another measure might be better. The older students can probably use the Smith et al. scale (attached), and it's likely more age appropriate. Or you might consider Roenneberg's scale (see attached papers).

Just a thought.

MAC

>Hi Dr. Carskadon,

>

>I am a Ph.D. candidate at the University of Southern Mississippi.

>My proposal is "MATCHING TIME OF DAY AND PREFERENCE FOR ADOLESCENT  
>ACHIEVEMENT".

>

>I am interested in your Children's Morningness & Eveningness

>Preference Instrument. I read that your MESC is a self-assessment

>type for children. The students in my study are high school

## APPENDIX F

## COMPUTER SCORING PROGRAM

A=0:B=0: TA=0: TB=0	REM Q Item Analysis Score Program for MESC
Input "enter for Question 1"; Answer	REM Initialize values
Go Sub A	
Input "enter for Question 2"; Answer	
Go Sub B	
Input "enter for Question 3"; Answer	
Go Sub A	
Input "enter for Question 4"; Answer	
Go Sub A	
Input "enter for Question 5"; Answer	
Go Sub A	
Input "enter for Question 6"; Answer	
Go Sub A	
Input "enter for Question 7"; Answer	
Go Sub B	
Input "enter for Question 8"; Answer	
Go Sub A	
Input "enter for Question 9"; Answer	
Go Sub B	
Input "enter for Question 10"; Answer	
Go Sub A	
?"Total MESC Score is";TA+TB	
End	REM of Main
A:	REM reverse counters
If Answer = 1 then a=a+5	
If Answer = 2 then a=a+4	
If Answer = 3 then a=a+3	
If Answer = 4 then a=a+2	
If Answer = 5 then a=a+1	REM inconsequential for questions 3, 4, 5, and 10
TA=TA+A	
return	REM end of sub
B:	REM only need four counters
If Answer = 1 then a=a+1	
If Answer = 2 then a=a+2	
If Answer = 3 then a=a+3	
If Answer = 4 then a=a+4	
TB=TB+A	
return	REM end of sub

## APPENDIX G

## HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE APPROVAL



The University of  
Southern Mississippi

Institutional Review Board

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Hattiesburg, MS 39406-0001  
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### HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.  
Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 27032911

PROJECT TITLE: Graphical Delivery Methods in Computerized Assessments

PROPOSED PROJECT DATES: 01/01/07 to 12/31/07

PROJECT TYPE: New Project

PRINCIPAL INVESTIGATORS: Leisha Moree Parker

COLLEGE/DIVISION: College of Education & Psychology

DEPARTMENT: Educational Leadership & Research

FUNDING AGENCY: N/A

HSPRC COMMITTEE ACTION: Exempt Approval

PERIOD OF APPROVAL: 03/29/07 to 03/28/08

Lawrence A. Hosman  
Lawrence A. Hosman, Ph.D.  
HSPRC Chair

4-2-2007  
Date

## APPENDIX H

## CLASSROOM RULES/PARENT PERMISSION FORM

## LAB RULES/PARKER/BREWER

- 1) No eating in the lab at any time.
- 2) Keep your hands to yourself. Never touch another person's computer.
- 3) Bring notebook and pen to class daily, you are not issued a text. Your notes will become your guide to word processing, information processing and programming efficiency. There are many procedures and hundreds of commands. Even the most knowledgeable computer person uses a reference manual. You are expected to keep your syllabus in your notebook also.
- 4) Personal software (games, etc.) cannot be used in here at any time. Viruses pose a real problem to the network.
- 5) Act like you are supposed to act. Be mature and be responsible.
- 6) In an effort to prevent mishaps, you must take your seat when you enter the lab. You are not to walk around and visit friends while waiting on the tardy bell to ring.
- 7) Respect electricity. Do not unplug anything. Report loose cables, down computer, etc. to me.
- 8) Keep your password to yourself. I alone will assign and change passwords as necessary.
- 9) Stay off the Internet unless assigned.
- 10) Makeup work must be completed the week following the absence. Schedule appointment time with me.

Parents:

Progress report dates are Feb. 5 and April 23.

Your signature here indicates that you have read and understand the above and grant permission for your child to use the Internet in this lab.

Your child has a \$3.00 lab fee. This entitles him or her to all the computer paper, diskettes, or cds used for secondary storage. At no time will your child have to supply their own paper, cds, diskettes, or print cartridge.

PARENT: \_\_\_\_\_ STUDENT: \_\_\_\_\_ DATE: \_\_\_\_\_

I use different methods of instruction in an effort to maximize each student's best learning style. This year, I will be collecting data about students' performance using time-of-day learning style. This research does not change, in any way, the instruction or the assessment of student performance that takes place but is simply a way of determining the most effective and beneficial test delivery time for each student. All student names will be confidential, poses no risk to your child, and all students will have the benefit of exploring their time-of-day learning style.

PARENT: \_\_\_\_\_ STUDENT: \_\_\_\_\_ DATE: \_\_\_\_\_



## REFERENCES

- Adolescent Sleep Needs and School Performance. (1998, November). *New York State United Teachers Bulletin*, 19.
- Ammons, T., Booker, J., & Killmon, C. (1995). *The effects of time of day on student attention and achievement*. Unpublished manuscript. Charlottesville: University of Virginia, Curry School of Education. (ERIC Document No. ED384592)
- Banks, R., & Atkinson, B. (2004). What is the best time of day for student learning? *Clearinghouse on Early Education and Parenting*. Retrieved August 12, 2008, from <http://ceep.crc.uiuc.edu/poptopics/timeofday.html>
- Biggers, J. L. (1980). Body rhythms, the school day, and academic achievement. *Experimental Education*, 49(1), 45-47.
- Callan, R. J. (1995). Early morning challenge: The potential effects of chronobiology on taking the scholastic aptitude test. *Clearing House*, 68(3), 175-177.
- Callan, R. J. (1998). An experimental investigation of the relationships among the time-of-day preferences of grade nine students taking a sequential test in Algebra and achievement in the test. Ed.D. dissertation, St. John's University, New York, United States – New York. Retrieved October 10, 2008, from Dissertations & Theses: Full Text database. (Publication No. AAT 9828754)
- Callan, R. J. (1998). Giving students the right time of day. *Educational Leadership*, 55(4), 84-87.
- Carskadon, M., Vieira, C., & Acebo, C. (1993). Association between puberty and delayed phase preference. *Sleep*, 16(3), 258-262.

- Carskadon, M. (1999). When worlds collide: Adolescent needs for sleep versus societal demands. *Adolescent Sleep Needs and School Starting Times*. Ed. Kyla Wahlstrom. *Phi Delta Kappan*, 80(5), 348-353.
- Cavallera, G., & Giudici, S. (2008). Morningness and eveningness personality: A survey in literature from 1995 up till 2006. *Personality and Individual Differences*, 44, 3-21.
- Cramp, D. (1990). A study of the effects on student achievement of fourth-and fifth-grade students' instructional times being matched or mismatched with their particular time preferences. Ph.D. dissertation, The University of Mississippi, Oxford, United States – Mississippi. Retrieved October 11, 2008, from Dissertations & Theses: Full Text database. (Publication No. AAT 9120281).
- Dunn, R. (1978). *Teaching students through their individual learning styles: A practical approach*. Reston, VA: Prentice-Hall.
- Dunn, R. (1990). Rita Dunn answer questions on learning styles. *Educational Leadership*, 48(2), 15-19.
- Dunn, R. (1995). Time of day preferences and achievement. Retrieved August 15, 2008, from [http://learn.humanesources.com/research\\_24.html](http://learn.humanesources.com/research_24.html)
- Dunn, R. (1998). Timing is everything. *Momentum*, 29(4), 23-25.
- Dunn, R., & Dunn, K. (1979). Learning styles/teaching styles: Should they ... can they ... be matched? *Educational Leadership*, 36, 238-244.
- Dunn, R., & Dunn, K. (1993). *Teaching secondary students through their individual learning styles*. Needham Heights, MA: Allyn and Bacon.

- Englund, C. E. (1979). Human chronopsychology: An autorhythmometric study of circadian periodicity in learning, mood and task performance. Ph.D. dissertation, United States International University, United States – California. Retrieved October 20, 2008, from Dissertations & Theses: Full Text database (Publication No. AAT 8019029).
- ExamView Test Generator. (2009). *einstruction.com/Products/ExamView/index.cfm*
- Gardner, H. (2006). *Theory of multiple intelligences*. New York: Basic Books.
- Gardner, H. (2008). E pluribus ... a tale of three systems. *Education Week*, 27(34), 40. [Online version]. Retrieved September 19, 2008, from <http://www.edweek.org/ew/articles/2008>
- Gadwa, K., & Griggs, S. (1985, September). The school dropout: Implications for counselors. *The School Counselor*. pp. 9-17.
- Goldstein, D., Hahn, H., Hasher, L., Wiprzycka, U., & Zelazo, P. (2006). Time of day, intellectual performance and behavioral personality and individual differences. *Personality and Individual Differences*, 42(3), 431-440.
- Hasher, L., Goldstein, D., & May, C. (2005). It's about time: Circadian rhythms, memory and aging. In C. Izawa & N. Ohta eds. *Human learning and memory: Advances in theory and application*. Kansas: Lawrence Erlbaum Associates.
- Jung, C. G. (1933). *Psychological types*. New York: Harcourt, Brace.
- Jung, C. G. (1954). *On the nature of the psyche*. Princeton University Press.
- Kamii, C., & Devries, R. (1993). *Physical knowledge in preschool education: Implications of Piaget's theory*. New Jersey: Prentice Hall.

- Kim, S., Dueker, G. L., Hasher, L., & Goldstein, D. (2002). Children's time of day preference: Age, gender, and ethnic differences. *Personality and Individual Differences*, 33, 1083-1090.
- Koch, K. (2007). A conversation with Dr. Rita Dunn. *Institute for Learning Styles Journal*. Vol 1. 1-11.
- Ramirez, C., Talamantes, J., Gardia, A., Morales, M., Valdez, P., & Menna-Barreto, L. (2006). Circadian rhythms in phonological and visuospatial storage components of working memory. *Biological Rhythm Research*, 37(5) 433-441.
- School mornings too early for studying teens. (2008, April). Retrieved August 12, 2008, from <http://www.abc.net.au/news/stories/2008/04>
- Science Blog. (2004). First circadian clock gene identified and cloned in mammals. Retrieved September 2, 2008, from <http://www.scienceblog.com/community>
- Smith, S. (1987). An experimental investigation of the relationships between and among achievement, preferred time of instruction and critical thinking abilities of tenth- and eleventh-grade students in mathematics. Ed.D. dissertation, St. John's University, New York, United States – New York. Retrieved October 23, 2008, from Dissertations & Theses: Full Text database. (Publication No. AAT 8811049).
- Sousa, D. (2003). *The leadership brain: how to lead today's schools more effectively*. Thousand Oaks, California: Corwin Press.
- Sylwester, R. (2007). *The adolescent brain*. Thousand Oaks, California: Corwin Press.
- United States Department of Education. (2001). No child left behind act of 2001. Retrieved June 28, 2008, from <http://www.ed.gov/nclb/landing.jhtml>

- United States Department of Education. (1983). A nation at risk. Retrieved June 25, 2008, from <http://www.ed.gov/pubs/NatAtRisk/risk.html>
- Virostko, J. (1983). An analysis of the relationships among academic achievement in mathematics and reading, assigned instructional schedules, and the learning style time preferences of third, fourth, fifth and sixth grade students. Ed.D. dissertation, St. John's University, New York, United States – New York. Retrieved October 30, 2008, from Dissertations & Theses: Full Text database. (Publication No. AAT 8322770)
- Wever, R. (1979). *Topics in environmental physiology and medicine: The circadian system of man*. In K. Schaefer, (Ed.) New York: Springer-Verlag.
- Wolfson, A., & Carskadon, M. (1998). Sleep schedules and daytime functioning in adolescents. *Child Development*, 69(4), 875-887.
- Wrobel, D. (1999). The impact of school starting time on family life. *Phi Delta Kappan*, 80(5), 360-364.
- Yoon, C., May, C., Goldstein, D., & Hasher, L. (2008). Aging, circadian arousal patterns, and cognition. In D. Park & N. Schwarz (Eds.), *Cognitive aging: A primer* (2<sup>nd</sup> ed.). Psychology Press.